Review article:

Present and Future Market Trends of Ornamental Fish in Iran: Challenges in Production, Supply, and Environmental Sustainability

Khiabani A.R.[1*], Razmi K.[2]

Received: June 2025 Accepted: August 2025

Abstract

The international trade in ornamental aquatic animals is shaped by multiple interconnected factors, including ecological, economic, political, regulatory, and socio-cultural dimensions. Although Iran imports and exports over 250 ornamental fish species, the industry continues to face substantial challenges in realizing its full potential. The aquarium trade has undergone significant expansion and diversification in recent years. However, the absence of standardized data collection protocols has led to a lack of comprehensive information on species volume and diversity, limiting the ability to analyze trade flows. Iran's ornamental fish production has expanded considerably, with a compound annual growth rate (CAGR) of about 8.96%, increasing from 147.9 million pieces in 2012 to 380.1 million in 2023. Despite this growth, export values have declined sharply in recent years, largely due to intensified banking and trade sanctions that have heightened investment risks. In 2016, Iran's ornamental fish exports peaked at $2.42 million, with a volume of 388,088 kg distributed across eight countries. By 2023, however, export values had contracted to approximately $0.76 million—a decline of nearly 68.5% over seven years. Addressing key barriers in Iran's ornamental aquaculture industry, particularly sanctions, could unlock opportunities for economic growth and job creation, strengthening Iran's role as a major ornamental fish producer in the Middle East. Conversely, failure to address these challenges may result in declining production, exports, and employment.

Keywords: Blue economy, Sustainability of ornamental fisheries, International trade of ornamental aquatic animals, Ornamental aquaculture.

1- Department of Agriculture & Natural Resources, University of Applied Science and Technology, Tehran, Iran
2- CSIRO Marine Laboratories, Australia
*Corresponding author's Email: khiabani@uast.ac.ir

[DOI: 10.22034/12.2.67]

Introduction

Aquarium keeping represents a globally popular pastime that has undergone significant evolution, fostering the expansion of the international ornamental fish trade into a multibillion-dollar sector. The global ornamental fish trade, encompassing both freshwater and marine species, is valued at approximately US$15–30 billion (INFOFISH, 2021; Pountney, 2023). The keeping of ornamental fish dates back at least a millennium (Novák *et al*., 2022; Stern *et al*., 2018; Walster *et al*., 2015) and the ornamental fish sector has experienced continuous growth within the pet market, with an annual growth rate of 14% since 1970 (Evers *et al*., 2019). The trade in marine ornamental fishes appears to have commenced around the 1930s (Biondo and Burki, 2020). The bulk of the trade is contributed by the freshwater species, whereas most of the marine ornamentals command a higher unit price over their freshwater counterparts (Anikuttan *et al*., 2022). The Global ornamental fish market saw export values rise from USD 21.5 million in 1976 to USD 315 million in 2007. Records of the global ornamental fish market, which began in 1976, show only 28 exporting countries at that time (Das, 2023; Monticini, 2010). Currently, over 180 countries trade in more than 2,500 aquatic species, with freshwater species comprising over 60% (Das, 2023). Aquarium extends beyond fish to include a diverse array of invertebrate species. The marine ornamental trade alone encompasses over 150 species of stony corals and hundreds of non-coral invertebrate species (Rhyne *et al*., 2012; Wabnitz, 2003). Current figures are estimates or inferred using limited information from formal and trade organizations (Biondo and Burki, 2020).

The international trade in ornamental aquatic animals is shaped by the sustainability of supply sources (wild populations and farms productions) (Biondo *et al*., 2024; Jan-Dec, 2016; Khiabani, 2024a), economic and market demand (Atalah *et al*., 2022; Monticini, 2010), regulations and health standards (Biondo *et al*., 2024; Monticini, 2010), environmental concerns (Biondo *et al*., 2024; Khiabani *et al*., 2025; Sekharan.N, 2021), animal rights, welfare, and ethical issues in trade (Ciliberti *et al*., 2024; Khiabani, 2019; Varner, 2022), and socioeconomic impacts in both producing and importing countries (Aly Pavitt *et al*., 2024). Challenges persist in areas such as regulatory frameworks, environmental issues and invasion risk assessments, trade data (Aly Pavitt *et al*., 2024; Biondo *et al*., 2024; Novák *et al*., 2025), cost price, trade restrictions, transportation, customs, insurance, animal health, nutrition management, breeding biotechnologies, and responsible trade management (Hempel, 2024; Jan-Dec, 2016; Khiabani *et al*., 2016; Khiabani *et al*., 2014; Khiabani *et al*., 2019; Monticini, 2010; Novák *et al*., 2025). Over the past decades, research in ornamental species has indicated exponential growth, especially within the aquaculture industry. It is expected that the value of ornamental trade will increase significantly in the next few

[DOI: 10.22034/12.2.67]

years. However, there is a lack of studies related to the field of ornamental species, in terms of mapping its trends (Peh and Azra, 2025).

The aim of this study was to conduct a comprehensive landscape as well as examine the current and predict future trends of the ornamental fish market in Iran.

Methodology

This study uses data from Iranian Fisheries Organization documents and reports, Islamic Republic of Iran Customs data, interviews with officials, and reputable databases and scientific articles, including Google Scholar, ResearchGate, FAO, Fishbase, Farsi reference books and news sites. To ensure valid and reliable results for an accurate analysis and future predictions of this industry, the opinions of 30 Iranian ornamental fish exporters and producers were gathered. Due to limited access to information and to facilitate the conversion of dates, the Solar Hijri calendar year (regardless of the beginning and end of the year) was converted to the Gregorian calendar.

Brief history in Iran

Keeping ornamental fish and other aquatics biota has a long history dating back to ancient times (Khiabani, 2015a; b; Komiyama *et al*., 2009), however, the modern era of ornamental aquaculture only started in the second half of the 19th century when the first tropical fish species were imported into Europe and the USA specifically for ornamental purposes (Khiabani, 2021; Novák *et al*., 2025). One of the oldest Farsi sources that refers to fish farming in Iran is *Ferdowsi's Shahnameh* (977–1010 CE), in which fish farming in clean waters is attributed to the period of the mythical king "*Jamshid"*. Which seems to refer to the era of the ancient *Iranian Empire* (Achaemenids) and their partial dominance over areas of Mesopotamia and the former habitat of the *Sumerians*, as one of the oldest civilizations of humanity that domesticated livestock and fish. While written accounts and the architectural significance of ponds and fish in ancient Iranian buildings are evident, a definitive historical record of ornamental fish keeping remains elusive. With this explanation, the history of aquaculture in Iran as a sustainable development strategy can be traced back to 1922 with the breeding of Sturgeon (*Acipenser* Sp.). While this initiative was not intended for the aquarium industry, it was motivated by environmental objectives and the conservation of aquatic resources within the Caspian Sea.

The precise introduction date of ornamental fish to Iran remains uncertain. However, it is estimated that goldfish (*Carassius auratus*) were introduced around 1900, coinciding with their introduction to Australia, New Zealand, and other nations globally, following their presence in England and France in the 17th century and the United States in 1878. Some accounts suggest their import to Iran occurred concurrently with the import of tea seedlings from India, also around 1900. A relatively recent addition to the

[DOI: 10.22034/12.2.67]

Iranian Nowruz celebration is the inclusion of goldfish, likely within the past century. This practice is believed to have been influenced by the 3,500-year-old Chinese New Year tradition. The painting "*New Year's Delivery*," also known as "*Haft Sin"*, by the esteemed artist *Hossein Sheikh* (*Hossein Ehya*), was created approximately 90 years ago and notably does not include a goldfish motif (Khiabani, 2021). This may seem insignificant at first, but the repeated introduction and release of this species into the wild will lead to unpleasant consequences for vulnerable aquatic ecosystems such as Iran. The introduction of Gambusia fish (as a type of ornamental fish) into Iranian aquatic ecosystems occurred between 1922 and 1930, with specimens sourced from Italy. This introduction was a deliberate measure aimed at the biological control of malaria, specifically targeting *Anopheles* mosquito populations. Gambusia's larvivorous feeding habits, preying on *Anopheles* larvae, offered a means of mitigating malaria transmission within Iran. The introduction was therefore purposed for public health intervention rather than for ornamental aquaculture (Coad, 1980; Jafari *et al*., 2019; Khiabani, 2024a; Tabibzadeh *et al*., 1970). However, we have witnessed numerous reports of them finding their way into other water sources and posing threats to native fish in Iranian waters such as *Aphanius* sp. (Coad, 1980; Jouladeh-Roudbar *et al*., 2020; Makki *et al*., 2021; Mousavi-Sabet, 2019). In recent years, the use of this fish has become popular again in some closed water sources and artificial ponds in Iran to prevent the spread of Dengue fever through the Aedes mosquito (*Aedes cinereus)*. In this regard, and in only one case, the release of 800 pieces of Gambusia fish by the municipality in Saveh County, Markazi Province, has been reported for this issue (Jokar, 2025).

The aquarium, ornamental fish, and related industries and trade have been present in Iran since the early 1960s, with a notable increase in aquarium keeping beginning in the early 1980s. During this period, the private sector initiated and maintained the import of ornamental fish, both directly and indirectly, from Southeast Asian nations. The earliest specialized books on aquariums and ornamental fish in Farsi are the translated Fish and Aquarium Pocket Book Series by *Rosario La Corte* (originally titled *Enjoy the Cichlids*, *Enjoy the Barbs*, *Enjoy the Tetras*, etc.). These translations, by *David Mousai* and published by Abnos Publications, appeared circa 1977-1980. These Farsi-language resources, combined with other scientifically published materials, attracted a broad audience to the aquarium and ornamental fish sector. The development of the ornamental fish breeding and farming industry reached its peak around 1985. The outbreak of the Iran-Iraq War (1970-1988) and the trade restrictions of that era could not completely prevent the development of this industry. Over this period, the landscape of ornamental fish farming transformed with the appearance of the first specialized breeding farms in what

[DOI: 10.22034/12.2.67]

are now Alborz, Markazi, and Golestan provinces (Khiabani, 2021). Ornamental aquaculture has provided benefits to scientific research and conservation efforts, such as studies of life requirements, reproduction, growth, ethology, ecology, and taxonomy. However, it has also had negative consequences, including biological invasions, the spread of associated symbionts and pathogens, poaching, and overharvesting (Khiabani, 2019; Maceda-Veiga *et al*., 2016; Novák *et al*., 2025; Rhyne *et al*., 2014).

Environment and habitats

In summary, the environment and habitats status of Iran's native ornamental aquatic animals can be divided and described into three main groups: the Caspian Sea and its southern basin, inland waters (including lakes, rivers, streams, and qanats), and southern waters including the habitats of the Persian Gulf and the Sea of Oman. The Caspian Sea and its southern basin are habitats for a wide range of the temperate waters ornamental fish (cold water ornamental fish) that, despite many commonalities with other water resources in Asia and Europe, have received less attention in the aquarium and ornamental fish industries in the world (Khiabani, 2024a). Elevated levels of heavy metals (Saeedi Saravi and Shokrzadeh, 2013), microplastics (Abadi *et al*., 2021), overfishing, habitat destruction, extensive dam construction (AnvariFar *et al*., 2011; Dumont, 1995; Madani, 2014) climate change, and oil industry pollution (UNEP, 2021) in the Caspian Sea raise serious concerns about ecosystem, food chain, and aquatic survival contamination. Iran's ornamental and non-ornamental aquatic species face a critical situation in inland waters due to a water bankruptcy crisis driven by over-extraction, dam construction, pollution of water resources, climate change, and mismanagement of water resources (AnvariFar *et al*., 2013; AnvariFar *et al*., 2011; Madani, 2014; Mousavi-Sabet, 2021). This has intensified the issue of the survival or permanent extinction of Iran's unique and common species (such as *Iranocichla hormuzensis*, I. *persa*, *Cobitis* sp., *Mastacembelus mastacembelus*, *Garra lorestanensis*, *Channa gachua*, *Pungitius platygaster*, *Gasterosteus aculeatus*, *Aphaniops* sp., *Paraphanius mento*, etc.) (Dadgar *et al*., 2014; Esmaeili *et al*., 2023; Esmaeili *et al*., 2016; Esmaeili *et al*., 2020; Gholamhosseini *et al*., 2022; Mousavi-Sabet, 2019; Patimar *et al*., 2010). In Brazil, 10% of hobbyists have released fish into the wild, raising concerns about biological invasions (Borges *et al*., 2022). Although there has been no comprehensive survey or study conducted on the number of people who have attempted this in Iran, the release of non-native freshwater ornamental fish species, including eight distinct species originating from the aquarium trade, in Iran has shown an increasing trend in recent years (Mousavi-Sabet, 2019).

More than 70% of the earth’s surface is covered by water, which is also where most of the world’s biodiversity is found. At least one third rely on corals

[DOI: 10.22034/12.2.67]

reefs (Knowlton *et al*., 2021). Oceans and aquatic organisms have been severely impacted by anthropogenic factors, such as globalization, climate change, overfishing, pollution (especially accumulation of marine debris originating from plastic), and sedimentation (Peixoto and Voolstra, 2023; Sankrityayan and Biswas, 2022). Trade of ornamental fish and aquarium supplies is extensive. But the multibillion-dollar marine ornamental fish trade relies on fish captured from coral reefs (Sankrityayan and Biswas, 2022). Notwithstanding the fact that this multimillion-dollar industry on the trade in decorative coral reef fauna is ever-expanding, but in some areas, weak coral reef ecosystems and their resident species are in danger due to unsustainable practices and a lack of effective management control (Sinha *et al*., 2023). Almost all marine ornamental fishes are wild-caught from coral reefs, and mortality rates throughout the supply chain can be high. The consequences of removing these fishes from their ecosystems are poorly understood (Biondo and Burki, 2020). Hence, the environmental impacts of the trade in ornamental fish are of considerable importance.

Sri Lanka as a country rich in marine environment, being one of the first countries to collect and export coral reef fishes for aquariums (Wood, 1985). Today, overexploitation and destructive practices like dynamite fishing, coral mining, and mechanized trawling have diminished fish stocks and damaged coral reefs, necessitating stronger governance and community involvement for sustainable management (Johanna Doerpinghaus *et al*., 2021; Ruwanpura and Mohamed-Saleem, 2025; Udugama *et al*., 2025; UNEP, 2001). The widespread demise of coral reefs due to climate change is now a certainty, and investing in restoration without facing this stark reality risks failure. With global emissions out of control, the most we can hope for is to buy precious time for coral reefs by saving coral species and coral diversity that will not likely survive unassisted (Bowden-Kerby, 2022). Possible solutions include creating artificial coral habitats, especially in sensitive marine habitats like the Persian Gulf, and establishing coral and sea anemone breeding centers. The propagation of ornamental coral in some leading countries such as Indonesia is considered a crucial element in fostering the decorative coral trade while mitigating ecological and environmental harm. Ornamental corals have garnered significant interest among hobbyists and have emerged as a source of foreign exchange for developing nations. Propagating ornamental coral ensures the sustainability of the ornamental coral trade and minimizes detrimental impacts. Indonesian ornamental coral exporters have developed propagation techniques in various locations throughout the country (Johan *et al*., 2023). Coral bleaching events in 1996, 1998, and 2002 severely impacted the Persian Gulf, reducing live coral cover to less than 1% in many shallow areas. Recovery has been

[DOI: 10.22034/12.2.67]

minimal, limited to deeper waters and areas with less human impact, with fishing remaining a major threat (Rezai *et al*., 2004). However, the total catch and the potential impact of exploiting marine ornamental aquatics in the Persian Gulf and the Oman Sea remain unknown. Artificial reefs enhance the biological, physical, and socioeconomic processes associated with natural reefs (Al Ismaili *et al*., 2024). Today, artificial habitats construction is being increased, and this has raised hopes for the restoration of coral habitats and increased the chances of survival of the ornamental fish native to the region. Notably, native species dominated the assemblages, suggesting that eco-engineered structures can promote native biodiversity even under highly stressful conditions. (Afzali and Nasrolahi, 2025). Given the data limitations inherent in ornamental fisheries, including insufficient information on population dynamics, stock status, and collection effort, compounded by the prevalence of illegal, under-reported, and unregulated fishing practices, conventional fisheries management approaches relying on stock assessments and total catch limits are rendered impractical. This problem is even evident in the assessment of fishery resources (edible aquatic animals) and marine habitats in southern Iran, including the Persian Gulf and the Sea of Oman. Therefore, a national monitoring system is urgently needed to collect timely and accurate data on habitat status, estimate the population of both ornamental and non-ornamental fish species in Iran, and enable rapid protection and management decisions.

Species and varieties

Significant concerns remain regarding trade in threatened or endangered species within this industry. This is particularly true for the illegal trade of marine species from southern Iranian waters and rare inland aquatic species. Because, Consumer preferences are a primary determinant of trends in the ornamental market (Sung and Fong, 2018). The marine ornamental fish trade is predominantly reliant on wild-caught specimens, with hatchery production accounting for a minor fraction (under 10%) of the overall supply. To mitigate the impact of fishing on wild populations and protect vulnerable coral reef ecosystems, which serve as habitats for the majority of marine ornamental species, hatchery production represents the only viable long-term solution (Anikuttan *et al*., 2022).

Clownfish constitute a significant portion of hatchery-produced fishes in the marine aquarium trade. Selective breeding has led to the emergence of designer clownfish (such as Domino, Platinum, Picasso, Phantom, and snowflake), which command higher prices due to their uncommon and visually appealing color variations. Nevertheless, a lack of published scientific research has resulted in public and hobbyist uncertainty regarding the origins (wild-caught, captive-bred, or genetically modified) and taxonomic classification of these designer clownfish (Anikuttan *et al*., 2022;

[DOI: 10.22034/12.2.67]

Khiabani, 2024b; Khiabani and Esmaeeili Ferydoni, 2017). Damselfishes (Pomacentridae) are the main saltwater species for which the production technology is institutionalized domestically and is produced well, but the origin of various species, such as *Amphiprion clarkii* found in the Persian Gulf and sold in the domestic market and surrounding Arab countries, is still unclear (Khiabani, 2024b; Khiabani and Esmaeeili Ferydoni, 2017). On the other hand, Iranian saltwater ornamental fish exports began before marine breeding techniques were developed and dedicated farms were established in the country. With this comparison, it can be said that part of the shipments exported from Iran are either dependent on imported varieties or varieties that have been harvested from nature. The issue remains unclear due to a lack of reliable information. The import of endangered ornamental aquatic species to other parts of the world and even to Iran is also subject to this rule. One such species is the Banggai cardinalfish (*Pterapogon kauderni*), a well-known aquarium species that is not protected internationally despite being on the IUCN Red List as an endangered species, and it is easily traded in this industry (Sinha *et al*., 2023). Species cardinal tetra (*Paracheirodon axelrodi*), zebra pleco (*Hypancistrus zebra*) and Clown loach (*Chromobotia macracanthus*) also fall under this rule, because their conservation status is of concern due to the overexploitation of wildlife, as has been repeatedly announced (Banha *et al*., 2019; Borges *et al*., 2022; Evers *et al*., 2019; Sale, 2002).

Doubts persist regarding the capacity of governments to effectively implement international agreements like CITES, particularly in developing nations with vulnerable economies, thereby raising concerns about the adequate protection of vulnerable species. To mitigate continued population declines among endangered, threatened, and protected species, it is imperative that governments, traders, sellers, and consumers reassess their respective roles and obligations concerning the trade of wild-caught ornamental species. Limited data and discrepancies arise from the absence of mandatory reporting for non-CITES listed species and their trade volumes. This lack of knowledge regarding conservation status is concerning, as most specimens are wild-caught. The impact of the ornamental fish trade on population status and trends remains largely unknown for most species, and the conservation status of many traded fish species is undetermined (Christi Linardich *et al*., 2024). In addition to this, the economic disparity between the importing and exporting countries within the trade can have social, environmental and economic ramifications for the poorer exporting countries (Sinha *et al*., 2023), For instance, it may incentivize people facing livelihood and economic hardship to exploit nature by smuggling species. Furthermore, mortality rates throughout the supply chain, from initial capture in the wild through to arrival to the

[DOI: 10.22034/12.2.67]

consumer, are largely unreported and unmonitored (Baillargeon *et al*., 2020; Rhyne *et al*., 2017). On the other hand, the volume of trade in purified varieties, popular hybrids, laboratory model species, and even genetically modified species is also uncertain (Khiabani, 2019).

Despite ongoing efforts by wildlife and ornamental fish advocates to discourage the production and trade of artificially colored, genetically engineered, or unusual hybrid ornamental fish, demonstrable progress remains limited. Reconciling economic imperatives with environmental and ethical considerations represents a significant challenge in securing a sustainable future for ornamental aquaculture. Key interventions include the development of animal welfare standards, implementation of sustainable aquaculture practices, adoption of environmental management policies, and promotion of ethically responsible business conduct (Ciliberti *et al*., 2024; Khiabani, 2019; 2024a). The IUCN compiled a list of 2,680 bony fish species found in the ornamental fish trade and conducted IUCN Red List assessments for 589 species (Christi Linardich *et al*., 2024). Obviously, before any commercial action is taken, the species in question must be matched to this list and its subsequent amendments. Without species-specific volume and diversity data, it is unclear how importing and exporting governments can oversee this industry effectively or how sustainability should be encouraged (Rhyne *et al*., 2017). The absence of this information and its subsequent lack of dissemination impede a realistic analysis of domestic and international market demands within this industry, leading to uncertainty in the production sector. The observed similarity in hatching priorities among ornamental fish producers may suggest a reliance on collective market trends rather than independent analysis of the previous year's sales data or future needs.

Ornamental aquaculture in Iran

Despite having several focal areas of ornamental fish biodiversity in Iran, including subtropical marine and coastal species of the Persian Gulf and the Sea of Oman, cold-water species of the southern Caspian Sea basin (temperate zone species), and subtropical habitats of the inland waters of the Iranian plateau, nevertheless, Iran's native and unique species have not yet entered the ornamental aquaculture chain and distribution network (Khiabani, 2024a). Aquaculture allows the aquarium industry to source organisms entirely from captivity, supporting species survival programs and preserving natural diversity (Lucas *et al*., 2019). Accordingly, the Asian Arowana (*Scleropages Formosus*), Bala Shark (*Balantiocheilos melanopterus*), Tequila fish (*Zoogoneticus tequila*), Golden skiffia (*Skiffia francesae*), Cardinalfish (*Pterapogon kauderni*), and Dwarf Botia (*Ambastaia sidthimunki*) are all endangered freshwater fishes in demand by the aquarium industry and have been conserved through aquaculture

[DOI: 10.22034/12.2.67]

production (De La Vega-Salazar *et al*., 2003; Khiabani, 2024a). The endangered *Sahyadria denisonii*, commonly known as the Red-line torpedo barb or "Miss Kerala," is now being successfully bred in captivity in India. This conservation initiative mitigates the pressure on wild populations, which were previously threatened by overexploitation for the ornamental fish trade. Captive breeding programs have contributed to increased local incomes and support the continued conservation of this endemic species. The IUCN listed S. denisonii as endangered in 2010, identifying intensive wild collection as the principal threat to its survival (Raghavan *et al*., 2009; Shivaji Argade *et al*., 2019). This species, as well as a variety of other species that have historically presented propagation challenges in biotechnology, are now being successfully propagated in Iran.

Skiffia francesae, the Golden Skiffia, is classified as Extinct in the Wild (EW) primarily due to habitat degradation caused by dam construction, pollution, water extraction, and the introduction of invasive species, which have severely impacted its native Río Teuchitlán habitat in Mexico. Invasive species currently make up to 95% of the fish population in these waters, further threatening native fishes like the skiffia. Conservation efforts over the past two decades have involved captive breeding at facilities such as the Fish Ark at Michoacan University and international collaboration with organizations like Chester Zoo and the Goodeid Working Group. In late 2022, more than 1,000 captive-bred skiffia were successfully reintroduced into protected semi-natural ponds (mesocosms) in their native habitat after extensive habitat restoration and invasive species control. Ongoing efforts include expanding breeding programs, restoring river habitats with native vegetation, improving water quality, scientific monitoring, and engaging local communities through education and stewardship projects. These collective actions aim to establish self-sustaining populations of Skiffia francesae in the wild and restore the ecological balance in the region's freshwater systems (De La Vega-Salazar *et al*., 2003; Kimbrough, 2022; Kingston, 1978; Koeck, 2019). The cherry barb (*Puntius titteya*), once vulnerable, has a chance to return to its natural environment thanks to its introduction to the aquarium industry and advancements in breeding techniques (Abeyrathne *et al*., 2022). Planned conservation efforts are crucial for protecting native ornamental fish in vulnerable habitats, especially given climate change and accelerating global warming. Iran's inland water habitats urgently need such measures, and the ornamental aquaculture sector is well-positioned to implement them.

Aquaculture production also plays a key role in supplying species listed on CITES Appendices I and II to the aquarium industry. Aquaculture production of giant clams (Tridacninae), seahorses (Syngnathidae), and hard corals (Scleractinia) allows for a sustainable and legal supply of these organisms, given their listing under

[DOI: 10.22034/12.2.67]

CITES Appendix II. In addition to supplying the aquarium industry with cultured organisms, aquaculture offers the opportunity for restocking natural populations that have been depleted or eliminated. Successful examples include barbs (*Barbus*) being reintroduced in Sri Lanka and giant clams being reintroduced to some Pacific islands (Southgate *et al*., 2016). Ornamental fish production and aquatic reproduction techniques should promote sustainable development, trade, and employment, while also addressing social responsibility in the biodiversity debate and the sustainability of at-risk plant and animal species. This is precisely what has been less addressed in recent years, leaving the country's inedible and economically low-value fish forgotten in the current water stress situation.

The global trade of ornamental fish is growing rapidly. However, documentation of the production of fish is limited, despite this, considerable inroads have been made to document the marine and freshwater trade; this information has primarily been focused on data collection via import/ export data and, as a result there is still limited information on the captive production of fish within a nation (Pountney, 2023). Ornamental fish hobbyists in Iran since before the 1979 revolution, and there is a paradigm shift both in production as well as in the marketing setup from the beginning of the 21st century. Production systems are shifting from traditional to scientific, semi-intensive, and intensive systems. In Iran, new production facilities feature recirculating aquaculture systems (RAS) and aquaponics for both outdoor and indoor units. Biofloc technology is currently in the experimental phase within this industry (Khanjani, 2019), but the production of live food (*Artemia*, *Rotifer*, *Daphnia*, Mealworm, etc.) and aquarium aquatic plants is at an acceptable level. Aquarium shops, once limited to metros and major cities, have proliferated and are now common in towns of all sizes.

As reported by the Deputy Director of Aquaculture Development of the Iranian Fisheries Organization, the ornamental fish farming industry in Iran encompasses 1750 active units, generating direct employment for an estimated 12600 individuals and indirect employment for a further 7000. Large producers account for 25% of ornamental fish producers in the country, medium-sized producers 55%, and small producers 20-30%. (Shakouri, 2025). Annual statistical reports from the Iranian Fisheries Organization indicate a growing trend in ornamental fish production. Ornamental fish production grew from 147,854,000 pieces in 2012 to 380,142,000 pieces in 2023, representing an approximate compound annual growth rate (CAGR) of 8.96% (Fig. 1). However, a notable proportion of ornamental fish production within the nation originates from small-scale, unlicensed domestic operations, a factor that introduces inaccuracies into the official statistical data for this sector. This is largely attributable to the government's stringent and intricate regulations, and unprofessional

[DOI: 10.22034/12.2.67]

approach to the issue. On the other hand, the statistics and figures rely primarily on production licenses issued, rather than field surveys or traceable online sales data. Statistical reports prior to 2012 from the Iranian Fisheries Organization primarily covered farmed and wild-caught edible aquatic animals, with limited data on farmed ornamental fish (IFO, 2010). Ornamental fish production occurs in all 31 provinces of the country Isfahan, Tehran, Qazvin, Gilan, Markazi, Alborz, Fars and East Azerbaijan are Iran's leading provinces in ornamental fish production, according to annual reports (IFO, 2024).

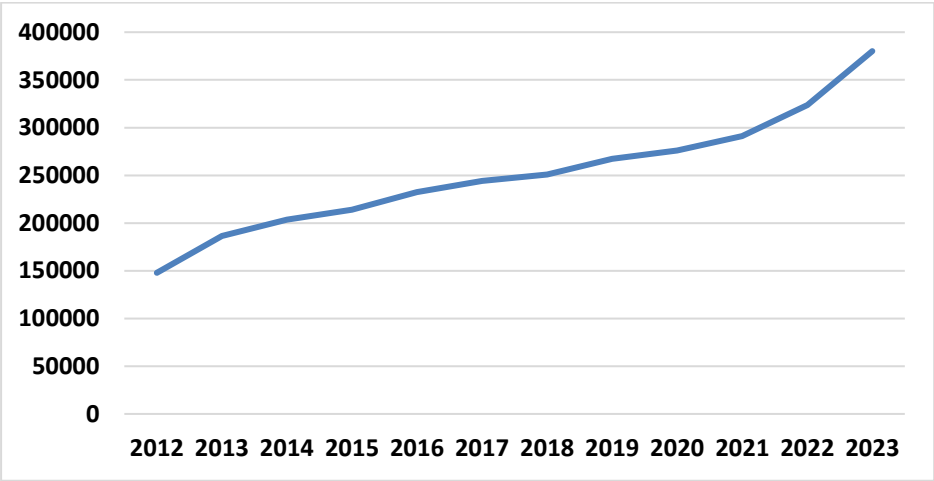

Figure 1: Report on the status of ornamental fish production in Iran; extracted from the statistical yearbooks of the Iranian Fisheries Organization (figures in thousands of pieces).

The organization does not provide details on ornamental fish species and varieties (freshwater or saltwater), aquatic plants, or live food and, as mentioned earlier, the absence of published statistics hinders production and export planning, thereby impeding sustainable development. From 2019 to 2023, Isfahan province led the nation in ornamental fish production with 362,597,000 pieces, while Kohgiluyeh and Boyer-Ahmad provinces had the lowest production at 1,385,000 pieces. The country produced 1.55 billion pieces over 5 years (Table 1). The unplanned aquaculture growth has accompanied with many environmental concerns about misuse of resources. In light of growing concerns regarding sustainability, aquaculture nations have implemented policy guidelines to govern industry development. The importance of the ecological problems to be solved due to haphazard aquaculture development necessitates new techniques and approaches to balance aquaculture development as well as environmental well beings (Jayanthi *et al*., 2022).

In Iran, five of the top ten ornamental fish-producing provinces (Isfahan, Tehran, Qazvin, Markazi, and Alborz) have faced severe water stress for years. East Azerbaijan, Khorasan Razavi, and Gilan are considered water-stressed, while Fars and Kerman provinces

[DOI: 10.22034/12.2.67]

experience water shortages (Fig. 2). This issue underscores the urgent need to address excessive groundwater and urban drinking water extraction, and to support the production sector by facilitating the mechanization of water recycling.

Table 1: Ornamental fish production statistics by province in Iran (thousands of pieces).

Rank	Province	2019	2020	2021	2022	2023	2019-2023
1	Isfahan	67,500	67,595	73,792	74,410	79,300	362,597
2	Tehran	37,885	37,145	38,930	46,311	59,648	219,919
3	Qazvin	29,260	31,245	33,299	38,964	52,460	185,228
4	Gilan	33,430	23,542	22,996	31,116	45,178	156,262
5	Markazi	12,272	14,169	16,085	17,140	17,931	77,597
6	Alborz	13,800	14,500	15,500	16,200	16,800	76,800
7	Fars	12,100	10,700	13,960	16,350	16,840	69,950
8	East Azerbaijan	6,200	13,075	14,482	16309	17,050	67,116
9	Razavi Khorasan	7,112	10,479	10,915	12,004	12,370	52,880
10	Kerman	6,750	9,750	8,350	7,950	4,250	37,050
11	Qom	4,450	5,760	6,560	7,200	8,000	31,970
12	West Azerbaijan	4,200	4,220	5,200	6,000	6,250	25,870
13	Kermanshah	4,000	4,500	4,600	5,000	4,900	23,000
14	Hamdan	4,280	4,510	4,248	4,605	4,843	22,486
15	Yazd	3,800	4,000	4,100	3,600	4,000	19,500
16	Golestan	3,249	3,297	3,306	3,400	3,500	16,752
17	Lorestan	2,765	2,925	3,015	3,176	3,305	15,186
18	Mazandaran	2,486	1,321	2,747	2,954	3,866	13,374
19	Ardabil	1,400	1,500	2,500	2,687	2,790	10,877
20	North Khorasan	1,345	2,000	2,000	2,222	2,400	9,967
21	Khuzestan	1,790	1,920	1,618	1,715	2,000	9,043
22	Ilam	1,500	1,700	1,200	2,000	2,100	8,500
23	South Khorasan	1,126	1,274	1,546	1,714	1,500	7,160
24	Kurdistan	1,340	1,370	1,370	1,270	1,316	6,666
25	Sistan and Baluchestan	851	1,090	952	1,200	1,519	5,612
26	Hormozgan	152	192	287	1,012	2,835	4,478
27	Zanjan	650	710	830	910	950	4,050
28	Chaharmahal and Bakhtiari	395	470	476	405	823	2,569
29	Bushehr	380	410	520	576	590	2,476
30	Semnan	455	455	470	510	528	2,418
31	Kohgiluyeh and Boyer Ahmad	315	315	255	200	300	1,385
	Total	267,238	276,139	296,109	329,110	380,142	1,548,738

[DOI: 10.22034/12.2.67]

Subsidies for energy sources and the failure to account for the true cost of water have significantly lowered the price of ornamental fish produced in Iranian farms, making these prices incomparable to those in regional and global markets. Lack of attention to Land-use planning and the unique capacities of each province in Iran has led to the unbalanced breeding of various ornamental fish in the country. In colder regions, there is a growing trend towards the production of warm-water (warm tanks) ornamental fish, shifting away from traditional cold-water (cool tanks) species suitable for unheated ponds and aquariums, such as Goldfish (*Carassius auratus*), Common bleak (*Alburnus alburnus*), Gudgeon (*Gobio gobio*), Golden shiner (*Notemigonus crysoleucas*), Red shiner (*Cyprinella lutrensis*), Diamond sunfish (*Enneacanthus obesus*), Three-spined stickleback (*Gasterosteus aculeatus*), Persian bitterling (*Rhodeus caspius*), Rainbow darter (*Etheostoma caeruleum*), Black-striped pipefish (*Syngnathus caspius*), and Weather loach (*Misgurnus anguillicaudatus*). Overlooking the ornamental aquaculture potential of native fish in Iran's subtropical waters is a missed opportunity. Unique and valuable ornamental species such as Teimori's tooth-carp (*Aphaniops teimorii*), Iranian cichlid (*Iranocichla hormuzensis*), Persian cichlid (I. *persa*), Dwarf snakehead (*Channa gachua*), Ceylon snakehead (C. *orientalis*), Farsi tooth-carp (*Esmaeilius persicus*), Cyrus mystus (*Mystus cyrusi*), Dussumier's mudskipper (*Boleophthalmus dussumieri*), etc., have no place in the production and supply of Iranian ornamental fish and have been forgotten. These trends highlight the need to focus the country's production capacity on specific missions. Therefore, Iran's ornamental aquaculture should prioritize sustainable production mechanisms over solely focusing on employment, aligning with national interests.

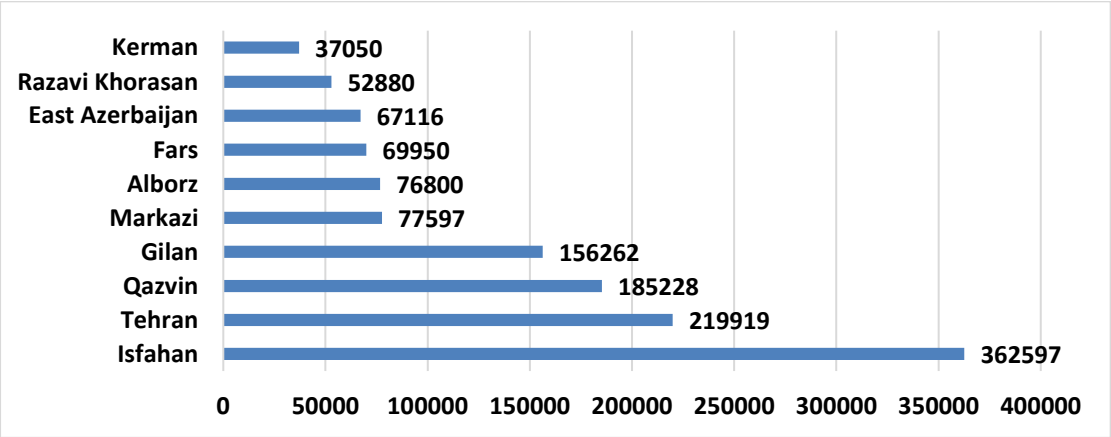

Figure 2: Top 10 ornamental fish producing provinces in Iran (Total 5 years ending 2023); extracted from the statistical yearbooks of the Iranian Fisheries Organization (figures in thousands of pieces).

[DOI: 10.22034/12.2.67]

Iran's ornamental fish trade

Asian countries dominate the global ornamental fish trade, accounting for over 65% of worldwide exports with US$250.48 million in 2021. While Asian exports experienced a slight CAGR of 0.84% between 2012 and 2021, Singapore, Japan, Indonesia, Myanmar, Thailand, Malaysia, and Sri Lanka remain key export hubs, collectively contributing to over 49% of the global export trade value (Das, 2023). Iranian trade's significance in the ornamental fish market is often overlooked due to insufficient data provided to international organizations.

As mentioned, annual statistical reports from the Iranian Fisheries Organization indicate a growing trend in ornamental fish production. Ornamental fish production grew from 147,854,000 pieces in 2012 to 380,142,000 pieces in 2023, representing an approximate compound annual growth rate (CAGR) of 8.96% (Fig. 3). Ideally, there should be a balance between the production, export, and import rates of ornamental fish in each country.

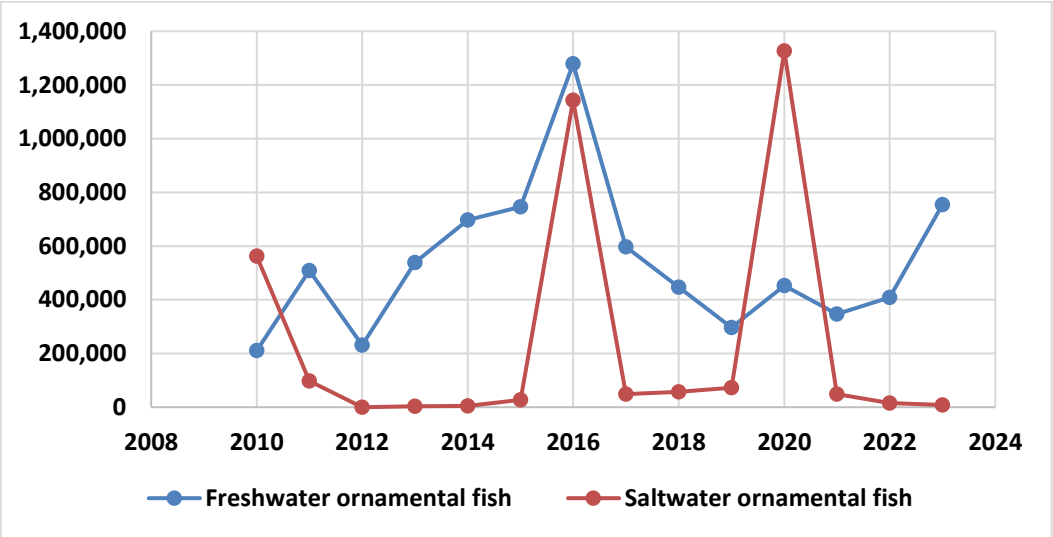

Figure 3: Iranian ornamental fish export value (USD), by freshwater (blue) and saltwater (orange) categories.

Table 2 shows the volume of Iranian ornamental fish exports from 2010 to 2023, according to data from the Islamic Republic of Iran Customs. Pre-2010 export statistics, based on ornamental fish size categories (up to 5 cm and over 5 cm), lack data on trade volume, shipment weight, and other technical details (CIRI, 2025). In 2023, Iran exported $762,040 worth of ornamental fish to Iraq, Turkey, the United Arab Emirates, Armenia, Kuwait, Thailand, Republic of Azerbaijan, Oman, and Bahrain. Live ornamental saltwater fish have been exported this year to only two destination countries: Oman (weighing 90 kilograms and worth $6,125) and the Republic of Azerbaijan (weighing 1,000 kilograms and worth $2,000). Iran's freshwater ornamental fish exports this year, in USD value and by cargo weight, are led by Iraq ($480,979, 455,279 kg)

[DOI: 10.22034/12.2.67]

and Turkey ($238,322, 11,920 kg), followed by the United Arab Emirates ($14,786, 586 kg), Armenia ($11,497, 1,570 kg), Kuwait ($5,659, 62 kg), Thailand ($2,500, 159 kg) and Bahrain ($462, 7 kg).

Cargo exports from airport customs terminals were as follows: Imam Khomeini International Airport (IKIA) recorded 9,029 kg, Isfahan Shahid Beheshti International Airport processed 1,799 kg, and Shahid Dastgheib International Airport, Shiraz, handled 80 kg, and other shipments were processed through land customs terminals. Road transit to Iraq, Türkiye, and the Republic of Azerbaijan constituted the highest land export volume (CIRI, 2025).

Table 2: Iranian ornamental fish export volume.

Year	Export value (in USD)			Weight value of cargo (kg)			Number of times sent			Number of destination countries	
	Freshwater	Saltwater	Total	Freshwater	Saltwater	Total	Freshwater	Saltwater	Total	Freshwater	Saltwater
2023	753,915	8,125	762,040	471000	1090	472,090	18	2	20	7	2
2022	408,661	15,028	423,689	269516	9400	278,916	55	13	68	6	2
2021	347,253	49,001	396,254	233256	16018	249,274	61	18	79	8	2
2020	453,271	1,326,040	1,779,311	404517	582195	986,712	57	15	72	6	2
2019	296,640	72,999	369,639	138740	23840	162,580	57	16	73	6	3
2018	446,894	57,133	504,027	142020	29748	171,768	43	15	58	5	2
2017	597,407	48,457	645,864	21424	19845	41,269	8	4	12	4	2
2016	1,278,566	1,143,129	2,421,695	18043	370045	388,088	10	4	14	5	3
2015	746,670	27,467	774,137	7529.5	28318	35,848	-	-	-	-	-
2014	696,872	5,375	702,247	26087	5645	31,732	8	1	9	4	1
2013	538,874	3,835	542,709	47688	2000	49,688	8	1	9	5	1
2012	230,753	0	230,753	29241	0	29,241	7	0	7	1	0
2011	509,483	97,721	607,204	14110	19809	33,919	7	3	10	2	2
2010	210,437	562,441	772,878	9,235	53185	62,420	3	3	6	1	1
Total	7,305,259	2,854,310	10,159,569	1,823,172	1,107,953	2,931,125	342	95	437	-	-

In 2021, Iran had the highest export destinations (8 countries), and in addition to the countries where ornamental fish from Iran were exported in 2023, the name of the country Sri Lanka ($540, 10 kg) is also seen. Iran's total export value of ornamental fish (freshwater and saltwater) experienced significant fluctuations between 2010 and 2023, and it reached a 13-year high in both 2016 and 2020. The Figure shows the export value of Iranian ornamental fish from 2010 to 2023, divided into freshwater and saltwater categories. Freshwater ornamental fish exports have generally shown a steady

[DOI: 10.22034/12.2.67]

increase from 2010, with a significant peak around 2016 exceeding 1.2 million USD and another noticeable rise in 2023 to about 750,000 USD. After the 2016 peak, freshwater exports dropped but remained at moderate levels, fluctuating between approximately 250,000 and 450,000 USD until the recent increase in 2023.

Saltwater ornamental fish exports, on the other hand, exhibit high volatility with sharp spikes in specific years. Initially high around 560,000 USD in 2010, they dropped to near zero for several years before surging again in 2016 to over 1.1 million USD. Another larger spike appears in 2020, exceeding 1.3 million USD, followed by a steep decline to near zero in subsequent years. Overall, the saltwater exports show unstable export values with quick rises and falls, unlike the more consistent pattern seen in freshwater exports. The coinciding peaks in 2016 for both types hint at possible shared external factors influencing exports that year.

In Figure 4, the cargo weight of Iranian freshwater and saltwater ornamental fish from 2010 to 2023 is shown, with considerable fluctuations throughout the years. The cargo weight remains relatively low and stable between 2010 and 2015, then spikes sharply in 2016 followed by a steep decline in 2017. From 2018 onward, the values demonstrate variability with a dramatic peak occurring in 2020 near 1,000,000 kg, followed by a rapid drop in 2021 and a gradual increase again in 2022 and 2023, though not reaching the earlier peak level.

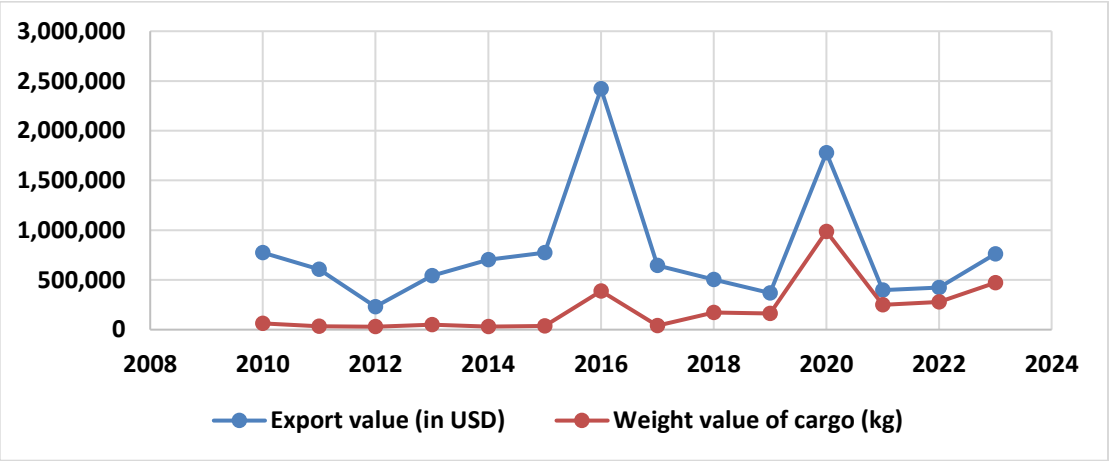

Figure 4: Value (in USD) and weight (kg) of Iran's ornamental fish export shipments Table 3. Iranian ornamental fish import volume.

According to the World Integrated Trade Solution (WITS) data from 2023, there are 88 countries that export ornamental fish. Japan leads with $48699000.92 USD, while Cote d'Ivoire is last with $60 USD (WITS, 2023). Although Iran's ornamental fish export statistics are not included in this report, considering the official report of the Islamic Republic of Iran Customs, it can be said that Iran ranks 33rd, higher than the Dominican Republic and lower than Kenya (CIRI, 2025; WITS, 2023). Ornamental fish exports to Afghanistan have been

[DOI: 10.22034/12.2.67]

suspended since 2019. In the last year prior to suspension, the trade volume reached $5,470.23 for 359 kg, with air transport being the method of correspondence. Besides the countries with active trade in 2023, Georgia, Pakistan, and Lebanon have been destination countries in the past five years, though with low trade volumes.

Table 3 shows the volume of Iranian ornamental fish imports from 2010 to 2023, according to data from the Islamic Republic of Iran Customs. Import statistics for ornamental fish prior to 2010, categorized by size (≤5 cm and >5 cm), do not include data on trade volume, shipment weight, or other technical specifications (CIRI, 2025). In 2023, Iran has also imported saltwater ornamental fish from Australia, Indonesia, Sri Lanka, Vietnam, and Kenya. For six consecutive years (2018-2023), freshwater ornamental fish have been imported to Iran from three countries: Indonesia, Malaysia, and Thailand, and in previous years, these countries have been the main source of imports to Iran. Iran's primary ornamental fish import terminal is the Imam Khomeini International Airport customs facility. In all these years, there has been only one reported import of saltwater ornamental fish from the United States, valued at $3,972 and weighing 487.

Table 3: Iranian ornamental fish import volume.

Year	Import value (in USD)			Weight value of cargo (kg)			Cargo receipt count			Number of countries of origin	
	Freshwater	Saltwater	Total	Freshwater	Saltwater	Total	Freshwater	Saltwater	Total	Freshwater	Saltwater
2023	586,908	141,087	727,995	56,129	10,455	66,584	3	5	8	3	5
2022	335,074	93,178	428,252	29,876	10,770	40,646	33	17	50	3	4
2021	310,953	184,528	495,481	49,829	25,471	75,300	36	16	52	3	4
2020	355,952	134,395	490,347	75,473	18,556	94,029	34	14	48	3	4
2019	471,650	313,236	784,886	102,553	31,821	134,374	37	18	55	3	3
2018	626,635	207,635	834,270	70,212	14,912	85,124	36	10	46	3	1
2017	275,162	642,339	917,501	7,623.30	30,548	38,171	2	1	3	2	1
2016	990,249	201,290	1,191,539	47,827	20,278	68,105	3	2	5	3	2
2015	1,416,518	558,379	1,974,897	66,234	51,316	117,550	3	4	7	3	4
2014	892,673	268,985	1,161,658	19,690.00	15,257	34,947	4	6	10	4	6
2013	1,748,133	671,942	2,420,075	82,511.50	50,896.25	133,408	5	7	12	5	7
2012	1,624,779	747,225	2,372,004	163,665	67,486.33	231,151	11	7	18	6	7
2011	2,054,692	486,402	2,541,094	286,347	84,226	370,573	11	5	16	9	4
2010	20,710	0	20,710	580	0	580	2	0	2	2	0
Total	11,710,088	4,650,621	16,360,709	1,058,550	431,993	1,490,542	220	112	332	-	-

Regarding Figure 5, the import value of freshwater ornamental fish in Iran was consistently higher than that of saltwater ornamental fish throughout the period

[DOI: 10.22034/12.2.67]

from 2010 to 2024. The freshwater fish import value peaked sharply above $2 million in 2011, followed by fluctuations and an overall decline into the later years, though with a slight upward trend observed after 2021. Saltwater ornamental fish imports, in contrast, peaked at around $700,000 in 2012 and generally showed a less volatile pattern with lower values, gradually decreasing after the peak and remaining relatively stable at lower levels towards the end of the period. Both categories showed their highest import values in the early 2010s, with freshwater imports maintaining a dominant position over saltwater imports across all years displayed.

Figure 6 illustrates the value and weight of Iran's ornamental fish import shipments from 2010 to 2023. The import value in USD peaked between 2011 and 2013, reaching over 2.4 million, followed by a general decline with a smaller peak in 2015. Meanwhile, the shipment weight in kilograms had its highest point around 2011, then sharply dropped and fluctuated at low levels thereafter. From 2016 on, both metrics show a downward trend with minor year-to-year changes, except for an increase in value in 2023 despite relatively low shipment weight. This indicates.

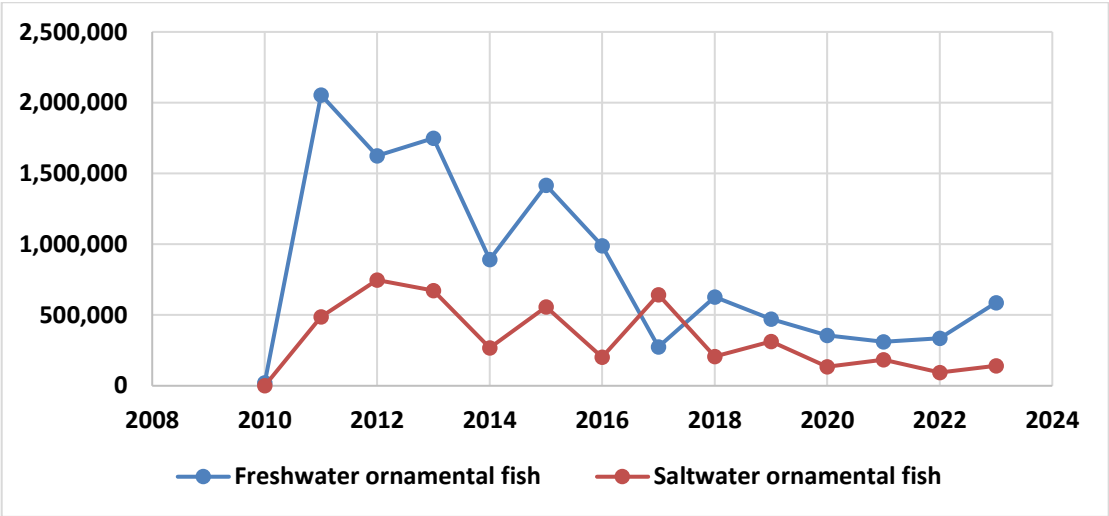

Figure 5: Iranian ornamental fish import value (USD), by freshwater (blue) and saltwater (orange) categories.

[DOI: 10.22034/12.2.67]

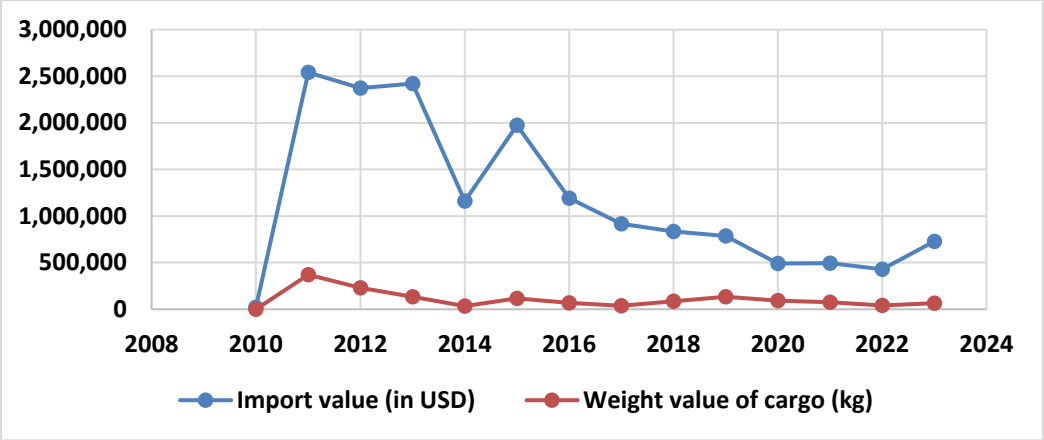

Figure 6: Value (in USD) and weight (kg) of Iran's ornamental fish import shipments.

Figure 7 provides a comparison of the export and import values of Iran's ornamental fish sector from 2010 to around 2023, showing considerable fluctuations over the years. Initially, import values sharply increased and dominated exports until 2016, reaching peaks above $2 million, while export values generally remained below $1 million, except for two significant spikes in 2016 and 2020 where exports temporarily surpassed imports. From 2016 onward, both imports and exports declined, with import values gradually dropping and export values showing sporadic surges but overall remaining low. In recent years (2021–2023), both exports and imports converted to similarly low levels, each below $1 million, indicating a reduction in both international trade activities in this sector.

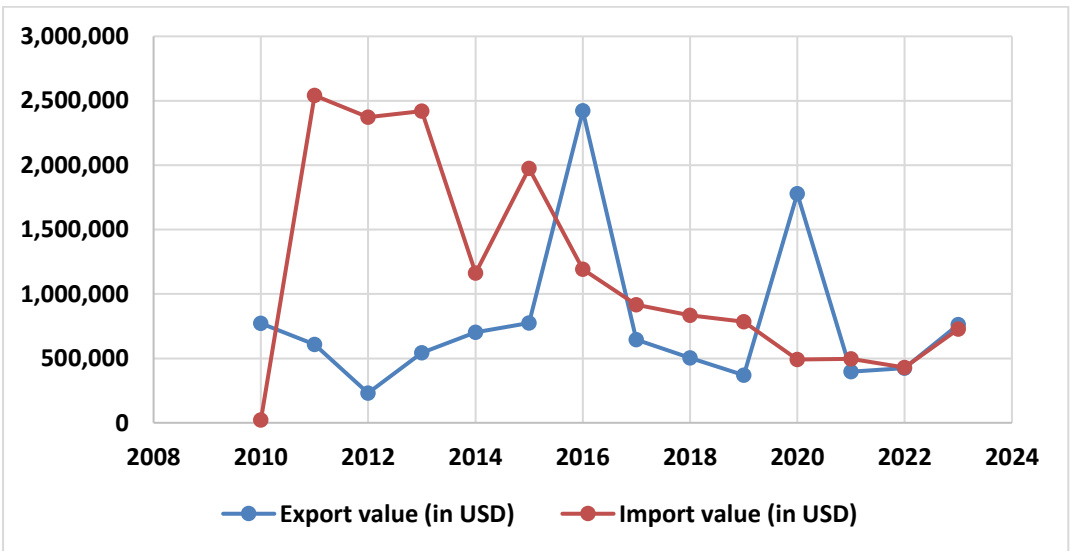

Figure 7: Comparison of Export and Import Value of Iran's Ornamental Fish (in USD) .

Figure 8 presents a comparison between the export and import weights of Iranian ornamental fish from 2010 to 2023. Throughout most of this period, the export weight remained variable but

[DOI: 10.22034/12.2.67]

generally lower than imports until 2017, when exports started to rise and significantly surpassed imports, peaking sharply in 2020 before dropping but still maintaining higher values than imports. Imports showed a peak in 2011 but declined steadily, stabilizing at a relatively low level in subsequent years. The data indicates a notable shift, with exports overtaking imports as the dominant trend after 2017, suggesting improved performance of Iran's ornamental fish exports relative to imports in recent years.

Reports on Iran's aquarium and ornamental fish industry lack data on related products like aquatic food, equipment, aquarium plants, supplements, and medicines. Nevertheless, Iran possesses considerable scientific and industrial infrastructure to support such endeavors.

Future prospects

Despite the import and export of over 250 ornamental fish species and variety in Iran, several challenges remain in realizing the full potential of the ornamental fish industry. Priority areas for improving Iran's ornamental fish industry, based on a survey and expert opinions from 30 top manufacturers, include: improving supply chain traceability and efficiency via contract farming, access to quality broodstock fish, upgrading transportation and packaging technologies, managing invasive species and diseases, addressing high production costs and low yields, reducing reliance on wild stock, ensuring sustainable water resources, and enhancing international trade. Improving market access and ensuring the ornamental fish industry's sustainability requires addressing the skilled manpower shortage, using biotechnology to produce specific species, upgrading ornamental fish farming, strengthening trade unions, implementing effective promotional marketing strategies, and securing appropriate government and banking support.

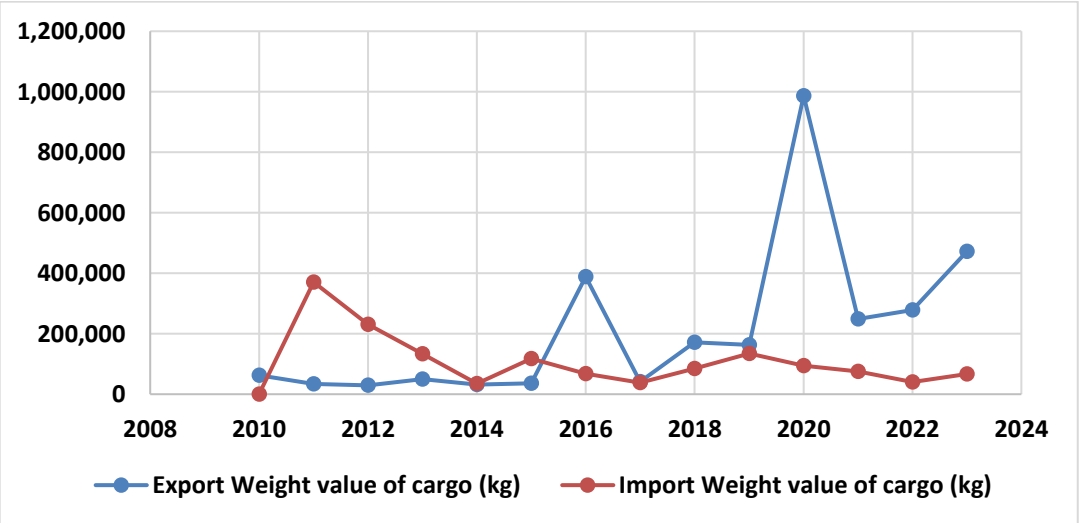

Figure 8: Weight comparison of Iran's ornamental fish exports and imports (kg).

[DOI: 10.22034/12.2.67]

Iran's ornamental fish industry, though still developing, is growing rapidly compared to other West Asian nations. Its proximity to both the European and West Asian markets give it a competitive edge over Southeast Asian producers due to lower transportation costs and higher survival rates. Besides, there is also high demand for ornamental fish in domestic market. The domestic ornamental fish market in Iran is thriving due to factors like rapid urbanization, a growing middle class, the need for companionship in families, and religious restrictions on other pets. Ornamental fish exhibitions and public aquaria further contribute to this market's development.

Iran's ornamental fish production has exhibited a strong and steady increase with a compound annual growth rate (CAGR) of approximately 8.96% from 2012 to 2023, growing from around 147.85 million pieces in 2012 to over 380 million pieces in 2023. This upward trend is expected to continue, potentially reaching nearly 480 million pieces by 2028. Resolving Iran's export challenges, particularly international sanctions, could unlock economic growth and job creation, solidifying its position as a top ornamental fish producer in the Middle East.

If contract farming gains momentum in Iran's ornamental fish industry, it can transform the sector by providing stable markets and guaranteed prices for small-scale breeders, boosting their income and reducing risks associated with market fluctuations. This system allows breeders to access better technical support, quality inputs, and financial resources from contracting companies, enabling the production of healthier, high-quality ornamental fish. The strengthened coordination across the supply chain (from producers to exporters and retailers) improves efficiency and helps expand export opportunities. Additionally, ornamental fish farming, often requiring relatively low startup costs, can empower women, youth, and rural communities by offering accessible entrepreneurship opportunities and job creation in emerging markets. Contract farming in ornamental fish promotes sustainability by reducing wild fish capture, conserving biodiversity, and driving innovation in high-value species, thus enhancing global competitiveness. This stable value chain ensures a steady supply for growing demand, boosting the ornamental fish trade's contribution to the blue economy and unlocking its full potential (Murekezi *et al*., 2018; Seidgar and Kargar Dehbidi, 2025). The sustainable development of aquaculture needs a long term and comprehensive plan, which is often difficult to formulate due to uncertainties of the future (Gephart *et al*., 2021).

Government estimates indicate that Iran has the potential to produce 380 million ornamental fish annually (IFO, 2024), but our results show that it is unlikely to be able to make a significant contribution to this international trade without intervention and macro-policy reform.

Realizing the market potential of both export and domestic market of

[DOI: 10.22034/12.2.67]

ornamental fish industry, Government of India has already earmarked Rs. 576 Cr for development of brood banks, rearing units, hatchery, infrastructure, and marketing activities for boosting up the ornamental fish sector. With an estimated 20% per annum growth, the ornamental fish trade in India is poised to reach Rs. 1500 cr. and generate livelihood opportunities for 0.7 million people through ornamental fisheries (Das, 2023). The lack of such strategic and supportive measures from the government and trade unions is felt in this industry in Iran. Increasing import taxes on ornamental fish species that are also produced domestically may foster local sustainable production and employment. Complementary to this policy, facilitating the import of bloodlines from popular ornamental fish species with strong market value would be beneficial. Solving banking issues and international sanctions, combined with leveraging Iran's scientific and technical capabilities, can create a positive outlook for Iran's ornamental fish industry through effective management policies based on land planning and sustainable development.

Conclusion

The results highlight key trends in Iran's fish production, exports, and imports. Although Iran's ornamental fish export statistics are not included in global reports, considering the official report of the Islamic Republic of Iran Customs, it can be said that in 2023, Iran ranks 33rd in the world's ornamental fish exports. Focusing on the condition of Iran's indigenous ornamental aquatic environments, land-use planning, sustainable development, strengthening technical knowledge, contract-based aquaculture, and the implementation of robust support and strategic policies can significantly advance ornamental aquaculture. Addressing challenges to Iranian exports, notably international sanctions, has the potential to stimulate economic expansion and generate employment opportunities, thereby reinforcing its standing as a leading producer of ornamental fish in the Middle East. The continued expansion of ornamental aquaculture presents opportunities to adopt environmentally sustainable technologies, prioritize the conservation of endangered native species, implement comprehensive global monitoring protocols, establish a national ornamental aquaculture codification framework encompassing import and export considerations, and issue a valid certificate to clarify the origin of the species being traded (caught from the wild or bred in captivity).

Reference

Abadi, Z.T.R., Abtahi, B., Grossart, H.P. and Khodabandeh, S., 2021. Microplastic content of Kutum fish, *Rutilus frisii kutum* in the southern Caspian Sea. *Science of The Total Environment,* 752, 141542. https://doi.org/10.1016/j.scitotenv.2020.141542

Abeyrathne, P., Ranatunga, R. and Madola, G., 2022. *Habitat and breeding ground preferences of the*

[DOI: 10.22034/12.2.67]

vulnerable fish species Sri Lankan Cherry Barb (Puntius titteya) according to the water quality in aquatic habitats in lowland wet zone, Sri Lanka. Paper presented at the Proceedings of the International Research Conference of SLTC.

Afzali, A. and Nasrolahi, A., 2025. Enhancing biodiversity on artificial coastlines with eco-engineered rock pools: Evidence from the Persian Gulf and Gulf of Oman. *Ecological Engineering,* 220, 107732. https://doi.org/10.1016/j.ecoleng.2025.107732

Al Ismaili, S., Al Masroori, H. and Dutta, S., 2024. Contribution of artificial reefs on fisheries productivity in the Sultanate of Oman from the fishermen perspective. *Ocean & Coastal Management,* 254, 107201. https://doi.org/10.1016/j.ocecoaman.2024.107201

Aly Pavitt, Klara Gaspar, Holly Mynott, Lauren Rudd, Matthew Hill, McLardy, C. and Malsch, A. K., 2024. International trade in non-CITES listed marine ornamental fish: International trade, conservation status, management and legislation for non-CITES marine ornamental fish in support of the implementation of Decision 18.296 [Updated] *UNEP-WCMC, Cambridge.*

Anikuttan, K.K., Rameshkumar, P., Nazar, A.K., Jayakumar, R., Tamilmani, G., Sakthivel, M., and Krishnaveni, N., 2022. Designer clown fishes: Unraveling the ambiguities. *Frontiers in Marine Science,* 9, 907362. https://doi.org/10.3389/fmars.2022.907362

AnvariFar, H., Farahmand, H., Silva, D., Bastos, R., Khyabani, A. and AnvariFar, H., 2013. Fourteen years after the Shahid-Rajaei dam construction: an evaluation of the morphometric and genetic differentiation between isolated up- and downstream populations of *Capoeta Capoeta gracilis* (Siah Mahi, Pisces: Cyprinidae) in the Tajan River (Iran). *Genetics and Molecular Research,* 12(**3**), 3465-3478. https://doi.org/10.4238/2013.September.10.3

AnvariFar, H., Khyabani, A., Farahmand, H., Vatandoust, S., AnvariFar, H. and Jahageerdar, S., 2011. Detection of morphometric differentiation between isolated up- and downstream populations of Siah Mahi (*Capoeta capoeta gracilis*)(Pisces: Cyprinidae) in the Tajan River (Iran). *Hydrobiologia,* 673(**1**), 41-52. https://doi.org/10.1007/s10750-011-0748-7

Atalah, J., Davidson, I.C., Thoene, M., Georgiades, E. and Hutson, K.S., 2022. Evaluating importation of aquatic ornamental species for biosecurity purposes. *Frontiers in Ecology and Evolution,* 9, 804160. https://doi.org/10.3389/fevo.2021.804160

Baillargeon, G.A., Tlusty, M.F., Dougherty, E.T. and Rhyne, A.L., 2020. Improving the productivity-

[DOI: 10.22034/12.2.67]

susceptibility analysis to assess data-limited fisheries. *Marine Ecology Progress Series,* 644, 143-156. https://doi.org/10.3354/meps13362

Banha, F., Diniz, A. and Anastácio, P., 2019. Patterns and drivers of aquarium pet discharge in the wild. *Ecological Indicators,* 106, 105513. https://doi.org/10.1016/j.ecolind.2019.105513

Biondo, M.V. and Burki, R.P., 2020. A systematic review of the ornamental fish trade with emphasis on coral reef fishes—an impossible task. *Animals,* 10(**11**), 2014. https://doi.org/10.3390/ani10112014

Biondo, M.V., Burki, R.P., Aguayo, F. and Calado, R., 2024. An updated review of the marine ornamental fish trade in the European Union. *Animals,* 14(**12**), 1761. https://doi.org/10.3390/ani14121761

Borges, A.K.M., Oliveira, T.P.R. and Alves, R.R.N., 2022. Marine or freshwater: the role of ornamental fish keeper's preferences in the conservation of aquatic organisms in Brazil. *PeerJ,* 10, e14387. https://doi.org/10.7717/peerj.14387

Bowden-Kerby, A., 2022. *Coral-focused climate change adaptation and restoration based on accelerating natural processes: Launching the "Reefs of Hope" paradigm.* Paper presented at the Oceans. https://doi.org/10.3390/oceans4010002

Christi Linardich, Jemelyn Grace P. Baldisimo, Kent E. Carpenter, Richard K.B. Jenkins and Tallowin, O.J.S., 2024. Evaluating the extinction risk of species targeted in the marine ornamental bony fish trade. *Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): Thirty-third meeting of the Animals Committee, Geneva (Switzerland), 12 – 19 July 2024*, 1-9.

Ciliberti, R., Alfano, L. and Petralia, P., 2024. Ethics in aquaculture: Animal welfare and environmental sustainability. *Journal of Preventive Medicine and Hygiene,* 64(**4**), E443. https://doi.org/10.15167/2421-4248/jpmh2023.64.4.3136

CIRI, 2025. Annual statistics of the Islamic Republic of Iran Customs (CIRI). *Islamic Republic of Iran Customs Portal,* https://B2n.ir/hu4689

Coad, B. W., 1980. Environmental change and its impact on the freshwater fishes of Iran. *Biological conservation,* 19(**1**), 51-80. https://doi.org/10.1016/0006-3207(80)90015-4

Dadgar, S., Marjani, M., Khiabani, A.M.S., Sharifian, M. and Sahafi Hosseinzadeh, H., 2014. Introducing Iranian Cichlid (*Iranocichla hormuzensis*): A special endemic aquarium species in Hormozgan Province. *Journal of Aquaculture Development,* 8(**2**), 83-87.

Das, D., 2023. Ornamental fish industry Hidden treasure for future economy. *Aquaculture Spectrum,* 6(**2**), 50-57. https://dor.isc.ac/dor/20.1001.1.23223545.1393.8.2.9.7

[DOI: 10.22034/12.2.67]

De La Vega-Salazar, M.Y., Avila-Luna, E. and Macías-Garcia, C., 2003. Ecological evaluation of local extinction: the case of two genera of endemic Mexican fish, *Zoogoneticus* and *Skiffia*. *Biodiversity & Conservation,* 12(**10**), 2043-2056. https://doi.org/10.1023/A:1024155731112

Dumont, H., 1995. Ecocide in the Caspian sea. *Nature,* 377(**6551**), 673-674. https://doi.org/10.1038/377673a0

Esmaeili, H.R., Sayyadzadeh, G. and Seehausen, O., 2016. *Iranocichla persa*, a new cichlid species from southern Iran (Teleostei, Cichlidae). *ZooKeys*, 636, 141. https://doi.org/10.3897/zookeys.636.10571

Esmaeili, H.R., Teimori, A., Zarei, F. and Sayyadzadeh, G., 2020. DNA barcoding and species delimitation of the Old World tooth-carps, family *Aphaniidae Hoedeman*, 1949 (Teleostei: Cyprinodontiformes). *PLoS One,* 15(**4**), e0231717. https://doi.org/10.1371/journal.pone.0231717

Esmaeili, H., Sayyadzadeh, G. and Abbasi, K., 2023. New Morphological and Molecular Data on the Southern Ninespine Stickleback, *Pungitius platygaster* (Gasterosteidae) from Southern Caspian Sea Basin. *Journal of Ichthyology,* 63(**6**), 1062-1071. https://doi.org/10.1134/S0032945223060036

Evers, H.G., Pinnegar, J.K. and Taylor, M.I., 2019. Where are they all from?–sources and sustainability in the ornamental freshwater fish trade. *Journal of Fish Biology,* 94(**6**), 909-916. https://doi.org/10.1111/jfb.13930

Gephart, J.A., Golden, C.D., Asche, F., Belton, B., Brugere, C., Froehlich, H.E., Fry, J.P., Halpern, B.S., Hicks, C.C., and Jones, R.C., 2021. Review scenarios for global aquaculture and its role in human nutrition. https://doi.org/10.1080/23308249.2020.1782342

Gholamhosseini, A., Razbanian, M., Esmaeili, H. and Eagderi, S., 2022. Molecular systematics and morphological variation in the Mesopotamian spiny eel *Mastacembelus mastacembelus* (Teleostei: Mastacembelidae). *The European Zoological Journal,* 89(**1**), 546-555. https://doi.org/10.1080/24750263.2022.2057604

Hempel, E., 2024. *The legacy of GLOBEFISH and the FISHINFONetwork*: Food & Agriculture Org.

IFO, 2010. Statistical Yearbook of the Iranian Fisheries Organization (2000-2009). *Office of Planning and Budget; Deputy of Planning and Management Development of the Iranian Fisheries Organization,* 1, 1-60. https://www.fisheries.ir/site/vahed_with_shakhes_v.aspx?uc=18

IFO, 2024. Statistical Yearbook of the Iranian Fisheries Organization (2019-2023). *Office of Planning and*

[DOI: 10.22034/12.2.67]

Budget; Deputy of Planning and Management Development of the Iranian Fisheries Organization, 1, 1-64. https://www.fisheries.ir/site/vahed_with_shakhes_v.aspx?uc=50746

INFOFISH, 2021. 3rd International Ornamental Fish Trade and Technical Virtual Conference. (ORNAMENTAL FISH -2021), Organised by INFOFISH and OFI. *http://ornamentalfish.infofish.org/images/pdf/3rd_ORNAMENTAL2021_brochure_fa.pdf*.

Jafari, A., Enayati, A., Jafari, F., Haghi, F.M., Hosseini-Vasoukolaei, N., Sadeghnezhad, R., Azarnoosh, M. and Fazeli-Dinan, M., 2019. A narrative review of the control of mosquitoes by Larvivorous fish in Iran and the world. *Iranian Journal of Health Sciences*. https://doi.org/10.18502/jhs.v7i2.1064

Jan-Dec, I., 2016. GLOBEFISH. *Globefish highlights*.

Jayanthi, M., Kumaran, M., Vijayakumar, S., Duraisamy, M., Anand, P., Samynathan, M., Thirumurthy, S., Kabiraj, S., Vasagam, K.P.K. and Panigrahi, A., 2022. Integration of land and water resources, environmental characteristics, and aquaculture policy regulations into site selection using GIS based spatial decision support system. *Marine Policy,* 136, 104946. https://doi.org/10.1016/j.marpol.2021.104946

Johan, O., Ginanjar, R., Budiyanto, A., Ardi, I., Priyadi, A. and Kunzmann, A., 2023. The success of ornamental coral propagation in Banyuwangi East Java, Indonesia: observation of different depths and species. *Frontiers in Marine Science,* 10, 928538. https://doi.org/10.3389/fmars.2023.928538

Johanna Doerpinghaus, Amarnath Munnolimath, Jana Hack, Samantha Kumarasena and Nisansala Ranundeniya, 2021. Prevention of Marine Litter in Sri Lanka. *European Union: in the framework of the project 'Prevention of Marine Litter in the Lakshadweep Sea (PROMISE)', POLICY BRIEF*, 1-13.

Jokar, T., 2025. Releasing 800 Gambusia fish in Saveh to combat the Aedes mosquito. *Science and Technology News, News Number: 17204.* https://stnews.ir/short/4yMoX.

Jouladeh-Roudbar, A., Ghanavi, H.R. and Doadrio, I., 2020. Ichthyofauna from Iranian freshwater: Annotated checklist, diagnosis, taxonomy, distribution and conservation assessment. *Zoological Studies,* 59, e21. https://doi.org/10.6620/ZS.2020.59-21

Khanjani, M.H., 2019. Application of Biofloc technology in aquaculture with an emphasis on ornamental fish. *Journal of Ornamental Aquatics,* 6(**2**), 35-47.

[DOI: 10.22034/12.2.67]

https://dor.isc.ac/dor/20.1001.1.24234575.1398.6.2.4.6

Khiabani, A., 2015a. Description the Siamese fighting fish (*Betta splendens*, Regan, 1910) in the Mekong basin. *Journal of Ornamental Aquatics,* 2(**3**), 37-42. https://dor.isc.ac/dor/20.1001.1.24234575.1394.2.3.5.1

Khiabani, A., 2015b. Reviewing on the Present Koi Carp (Pisces: Cyprinidae). *Journal of Ornamental Aquatics,* 2(**1**), 37-41. https://dor.isc.ac/dor/20.1001.1.24234575.1394.2.1.6.8

Khiabani, A., 2019. Review of the Ethical and Technical Principles of Working with Zebrafish as a Species of the Biological Model in Medical Science Studies. *Iranian Journal of Medical Ethics and History of Medicine,* 12(**1**), 58-72. http://ijme.tums.ac.ir/article-1-6120-fa.html

Khiabani, A., 2021. Principles of Aquarium Engineering (Design, Construction and Equipping), Agricultural Publishing (Agricultural Education and Extension Institute). 1-376. https://agrilib.areo.ir/book_9799.html

Khiabani, A., 2024. A review on the reproduction and breeding biotechnology of clownfish (*Amphiprion* sp.) as a laboratory model species. *Journal of Ornamental Aquatics,* 11(**1**), 39-62. https://dx.doi.org/10.22034.11.1.39

Khiabani, A., 2024. Review on the ornamental fish species potentials of the Caspian Sea and its Southern Basin. *Caspian Journal of Environmental Sciences*, 1-16. https://doi.org/10.22124/cjes.2024.7967

Khiabani, A. and Esmaeeili Ferydoni, A., 2017. Review of Biology & Breeding of the Clownfish under Captivity. *Journal of Ornamental Aquatics,* 4(**1**), 13-19. https://dor.isc.ac/dor/20.1001.1.24234575.1396.4.1.3.9

Khiabani, A., Anvarifar, H. and Mousavi-Sabet, H., 2016. Effect of dietary administration of methyltestosterone and vitamin C on the sex reversal and survival of *Xiphophorus maculatus* (Cyprinodontiformes: Poeciliidae). *Poeciliid Research,* 6(**1**), 16-24.

Khiabani, A., Anvarifar, H., Safaeian, S. and Tahergorabi, R., 2014. Masculinization of swordtail *Xiphophorus hellerii* (Cyprinodontiformes: Poeciliidae) treated with 17α-methyltestosterone and vitamin E. *Global Research Journal of Fishery Science and Aquaculture,* 1(**5**), 021-025.

Khiabani, A., Keramat, A. and Tahergorbi, R., 2019. Use of Highly unsaturated fatty acid (HUFA) in Ornamental Fish Feeds. *Survey in Fisheries Sciences,* 6(**1**), 64-76. https://doi.org/10.18331/SFS2019.6.1.7

Khiabani, A., Ouraji, H. and Esmaeili Fereidouni, A., 2025. Determination of lethal concentration (LC50) of silver nanoparticles (AgNPs) produced by chemical methods in

[DOI: 10.22034/12.2.67]

Zebrafish (*Danio rerio*). *International Journal of Biological Reports,* 4(**1**), 1-12. https://doi.org/10.22034/INJBIR.3.1.1

Kimbrough, L., 2022. Amid Mexico's Day of the Dead, a fish declared extinct comes back to life. *Mongabay news platform*.

Kingston, D.I., 1978. Skiffia francesae, a new species of goodeid fish from Western Mexico. *Copeia*, 503-508.

Knowlton, N., Corcoran, E., Felis, T., de Goeij, J., Grottoli, A., Harding, S., Kleypas, J., Mayfield, A., Miller, M., and Obura, D., 2021. Rebuilding coral reefs: a decadal grand challenge. https://doi.org/10.53642/NRKY9386

Koeck, M., (2019). "*Skiffia francesae*". *The IUCN Red List of Threatened Species 2019: e.T20285A2757376. Accessed on 18 September 2025.* https://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T20285A2757376.en.

Komiyama, T., Kobayashi, H., Tateno, Y., Inoko, H., Gojobori, T. and Ikeo, K., 2009. An evolutionary origin and selection process of goldfish. *Gene,* 430(**1-2**), 5-11. https://doi.org/10.1016/j.gene.2008.10.019

Lucas, J.S., Southgate, P.C. and Tucker, C.S., 2019. *Aquaculture: Farming aquatic animals and plants*: John Wiley & Sons.

Maceda-Veiga, A., Domínguez-Domínguez, O., Escribano-Alacid, J. and Lyons, J., 2016. The aquarium hobby: can sinners become saints in freshwater fish conservation? *Fish and Fisheries,* 17(**3**), 860-874. https://doi.org/10.1111/faf.12097

Madani, K., 2014. Water management in Iran: what is causing the looming crisis? *Journal of environmental studies and sciences,* 4(**4**), 315-328. https://doi.org/10.1007/s13412-014-0182-z

Makki, T., Mostafavi, H., Matkan, A.A. and Aghighi, H., 2021. The effects of climate change on the distribution of an invasive fish in Iran: *Gambusia holbrooki* (Girard, 1859). *Journal of Applied Ichthyological Research,* 9(**1**), 1-10. https://doi.org/10.22034/jair.9.1.1

Monticini, P., 2010. The Ornamental Fish Trade, Production and Commerce of Ornamental Fish: technical-managerial and legislative aspects *GLOBEFISH RESEARCH PROGRAMME, 102*, 134.

Mousavi-Sabet, H., 2019. Exotic ornamental fishes in Iranian inland water basins: an updated checklist. *Journal of Animal Diversity,* 1(**1**), 1-10. https://doi.org/10.29252/JAD.2019.1.1.1

Mousavi-Sabet, H., 2021. Dams and their impacts on fishes in Iran. In *Tigris and Euphrates rivers: Their environment from headwaters to mouth. Cham: Springer International Publishing*. 401-420. https://doi.org/10.1007/978-3-030-57570-0_17

Murekezi, P., Menezes, A. and Ridler, N. B., 2018. *Contract farming and public-private partnerships in aquaculture: Lessons learned from*

[DOI: 10.22034/12.2.67]

East African countries: Food and Agriculture Organization of the United Nations.

Novák, J., Hohl, D., Stuchlík, M., Hofmann, J., Tlusty, M. F., Magalhães, A.L.B., Maceda-Veiga, A., Akmal, S. G., Yue, G.H., and Kumkar, P., 2025. Revisiting the history of ornamental aquaculture in Europe to understand the benefits and drawbacks of freshwater fish imports. *Reviews in Aquaculture,* 17(**2**), e13008. https://doi.org/10.1111/raq.13008

Novák, J., Magalhães, A.L.B., Faulkes, Z., Maceda-Veiga, A., Dahanukar, N., Kawai, T., and Patoka, J., 2022. Ornamental aquaculture significantly affected by the "Czech aquarium phenomenon". *Aquaculture,* 555, 738259. https://doi.org/10.1016/j.aquaculture.2022.738259

Patimar, R., Najafabadi, M.H. and Souraki, M.G., 2010. Life history features of the nonindigenous three-spined stickleback (*Gasterosteus aculeatus* Linnaeus, 1758) in the Gomishan wetland (southeast Caspian Sea, Iran). *Turkish Journal of Zoology,* 34(**4**), 461-470. https://doi.org/10.3906/zoo-0903-25

Peh, J.H. and Azra, M.N., 2025. A global review of ornamental fish and shellfish research. *Aquaculture,* 596, 741719. https://doi.org/10.1016/j.aquaculture.2024.741719

Peixoto, R.S. and Voolstra, C.R., 2023. The baseline is already shifted: marine microbiome restoration and rehabilitation as essential tools to mitigate ecosystem decline. *Frontiers in Marine Science,* 10, 1218531. https://doi.org/10.3389/fmars.2023.1218531

Pountney, S.M., 2023. Survey indicates large proportion of fishkeeping hobbyists engaged in producing ornamental fish. *Aquaculture Reports,* 29, 101503. https://doi.org/10.1016/j.aqrep.2023.101503

Raghavan, R., Prasad, G., Pereira, B., Anvar Ali, P. and Sujarittanonta, L., 2009. 'Damsel in distress'-The tale of Miss Kerala, Puntius denisonii (Day), an endemic and endangered cyprinid of the Western Ghats biodiversity hotspot (South India). *Aquatic Conservation: Marine and Freshwater Ecosystems,* 19(**1**), 67-74.

Rezai, H., Wilson, S., Claereboudt, M. and Riegl, B., 2004. Coral reef status in the ROPME sea area: Arabian/Persian Gulf, Gulf of Oman and Arabian Sea. *Status of coral reefs of the world,* 1, 155-170.

Rhyne, A.L., Tlusty, M.F. and Kaufman, L., 2014. Is sustainable exploitation of coral reefs possible? A view from the standpoint of the marine aquarium trade. *Current Opinion in Environmental Sustainability,* 7, 101-107. https://doi.org/10.1016/j.cosust.2013.12.001

Rhyne, A.L., Tlusty, M.F., Schofield, P.J., Kaufman, L., Morris Jr, J.A. and Bruckner, A.W., 2012. Revealing the appetite of the marine

[DOI: 10.22034/12.2.67]

aquarium fish trade: the volume and biodiversity of fish imported into the United States. *PLoS One,* 7(**5**), e35808. https://doi.org/10.1371/journal.pone.0035808

Rhyne, A.L., Tlusty, M.F., Szczebak, J. and Holmberg, R.J., 2017. Expanding our understanding of the trade in marine aquarium animals. *PeerJ* ,5, e2949*, 3*, e1176v1172. https://doi.org/10.7717/peerj.2949

Ruwanpura, K.N. and Mohamed-Saleem, A., 2025. *Routledge Handbook of Contemporary Sri Lanka*: Taylor & Francis.

Saeedi Saravi, S. and Shokrzadeh, M., 2013. Heavy metals contamination in water and three species of most consumed fish sampled from Caspian Sea, 2011. *Environmental Monitoring and Assessment,* 185(**12**), 10333-10337. https://doi.org/10.1007/s10661-013-3335-8

Sale, P.F., 2002. *Coral reef fishes: dynamics and diversity in a complex ecosystem*: Elsevier.

Sankrityayan, P. and Biswas, S., 2022. Plastic Filtration and Decomposition According to Ricochet Filtering Mechanism Using Ideonella sakaiensis. *Frontiers in Marine Science, 9*, 919743. https://doi.org/10.3389/fmars.2022.919743

Seidgar, M. and Kargar Dehbidi, N., 2025. The role of contract aquaculture in the country's ornamental fish industry. *Journal of Ornamental Aquatics,* 12(**2**), 47-56. https://doi.org/10.22034/12.2.47

Sekharan, N.M., 2021. Global trade in marine ornamental fish. *INFOFISH International*(No 1/2021), 29-32.

Shakouri, M., 2025. Production of 550 million ornamental fish was targeted in the Seventh Development Plan. *Mehr News Agency. News Number: 6481860.* https://mehrnews.com/x386FS

Shivaji Argade, Bharat Yadav, Bhalchandra Naik, Sandesh Patil and Rathod, R., 2019. Ornamental Fish 'Miss Kerala' Culture Management and Conservation - A Success Story. *International Collective in Support of Fishworkers,, Krishi Jagran Media Group*.

Sinha, A., Pandey, P.K. and Ghosh, S., 2023. Ornamental fishing industry. *Frontiers Media SA*. Vol. 10, pp. 1245218.

Southgate, P.C., Braley, R.D. and Militz, T.A., 2016. Embryonic and larval development of the giant clam *Tridacna noae* (Röding, 1798) (Cardiidae: Tridacninae). *Journal of Shellfish Research,* 35(**4**), 777-783. https://doi.org/10.2983/035.035.0406

Stern, N., Rachmilovitz, E.N., Sharon, G. and Diamant, A., 2018. The dire implications of releasing marine ornamental fishes into the wild: first reported case from the Red Sea. *Marine Biodiversity,* 48(**3**), 1615-1620. https://doi.org/10.1007/s10641-011-9795-1

[DOI: 10.22034/12.2.67]

Sung, Y.H. and Fong, J.J., 2018. Assessing consumer trends and illegal activity by monitoring the online wildlife trade. *Biological Conservation,* 227, 219-225. https://doi.org/10.1016/j.biocon.2018.09.025

Tabibzadeh, I., Behbehani, G. and Nakhai, R., 1970. Use of Gambusia fish in the malaria eradication programme of Iran. *Bulletin of the World Health Organization,* 43(**4**), 623.

Udugama, M., Udayanga, L., Gonapinuwala, S. and de Croos, D., 2025. Marine Pollution due to Mariculture and Fishing Operations in Sri Lanka: Impacts and Mitigation Strategies. *Coastal and Marine Pollution: Source to Sink, Mitigation and Management*, 163-181. https://doi.org/10.1002/9781394237029.ch8

UNEP, 2001. Sri Lanka: State of the Environment. *The United Nations Environment Programme (UNEP)* 1-144.

UNEP, 2021. https://www.unep.org. (Accessed 20 April 14, 2021).

Varner, B., 2022. Farm Fisheries: An Analysis of the Animal Welfare Concerns. *Animal Legal & Historical Center, Michigan State University*.

Wabnitz, C., 2003. *From ocean to aquarium: the global trade in marine ornamental species*: UNEP/Earthprint.

Walster, C., Rasidi, E., Saint-Erne, N. and Loh, R., 2015. The welfare of ornamental fish in the home aquarium. *Companion Animal,* 20(**5**), 302-306. https://doi.org/10.12968/coan.2015.20.5.302

WITS, 2023. Live ornamental fish exports by country in 2023. *The World Integrated Trade Solution (WITS),* https://wits.worldbank.org/Default.aspx?lang=en.

Wood, E., 1985. Exploitation of coral reef fishes for the aquarium trade. 121P.

[DOI: 10.22034/12.2.67]